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Abstract

Learners need to have good reasons to engage and accept e-learning. They need to understand that unless they do, the outcomes will be less favourable. The technology acceptance model (TAM) is the most widely recognized model addressing why users accept or reject technology. This study describes the development and evaluation of a virtual environment, the online 3D world Second Life (SL), for learning rapid sequence intubation (RSI). RSI is an increasingly frequently used method of acute airway management in healthcare settings. The intention of learners to use the system was explored based on the TAM, with the computer self-efficacy construct as an external variable. Two hundred and six nursing students participated in this study. The findings suggest that the system was perceived as useful, and that the students felt confident working with computers and intended to review RSI in SL as often as needed. However, they remained neutral regarding the ease of use of the system. Strategies were suggested for boosting the students' self-confidence in using the system. Overall use of the TAM in this context was successful, indicating the robustness of the model. The limitations of the study were discussed and further areas of research on the TAM were proposed.

Keywords: technology acceptance model, 3D learning environment; Second Life; virtual ward; intubation; airway management

1. Introduction

In recent years, the Internet and technological evolution have brought highly dynamic communication, and enabled e-learning initiatives to grow and meet a wide range of educational needs. e-Learning allows learners to save time by not having to commute, and to take lessons at their own pace and in the sequence that they prefer. Through ubiquitous computing and novel technologies, online courses are becoming more popular as people come to appreciate the innovative e-learning experiences. The impact of information and communication technology (ICT) on teaching and learning has generated research investigating both the extent of ICT usage and the technical aspects of e-learning. However, there is a dearth of research on the reactions of learners towards e-learning and their acceptance of it. Owing to the crucial role that e-learning plays in teaching and learning, it has been suggested that future research should incorporate greater coverage of the determinants that have an impact on e-learning (Teo, 2010). Learners need to have good reasons to engage in and accept e-learning and to understand that, unless they do, the outcomes will be less favourable. A review of prior studies suggests that the technology acceptance model is one of the most frequently used theoretical frameworks in addressing why users accept or reject technology.

2. Technology acceptance model

Substantial theoretical and empirical evidence has accumulated over the decades in favour of the technology acceptance model (TAM) (Davis, 1986; 1989), which has come to be one of

the most widely applied theoretical models for explaining and predicting user acceptance of specific types of technology (Holden & Karsh, 2010; King & He, 2006; Legris et al., 2003). TAM is predictive in nature and attempts to uncover the constructs that have an impact on the intentions of people to use technology. It conceptualizes that an individual’s intention to use a system is determined by two beliefs: perceived usefulness and perceived ease of use. Perceived usefulness is also posited as being directly impacted by perceived ease of use. Numerous studies have found that the model consistently explains a substantial proportion of the variance (typically about 40%) in usage intentions, and that it compares favourably with alternative models such as the Theory of Reasoned Action and the Theory of Planned Behaviour (Venkatesh & Davis, 2000).

TAM has been the instrument in many empirical studies, in part because it is simple to use and easy to understand. Nevertheless, a number of external variables have been introduced into TAM to gain a better understanding of the actions that can be taken to improve the predictability of technology acceptance. For example, researchers have extended TAM by adding perceived enjoyment (Lee, Cheung & Chen, 2005), system and learner characteristics (Pituch & Lee, 2006), e-learning self-efficacy (Park, 2009), flow concept (Sanchez-Franco, 2010; Lu et al., 2009; Liu, Liu & Pratt, 2009), compatibility (Chen & Tan, 2004), and technical support (Elbeltagi et al., 2005). An extension to TAM that has been studied repeatedly is computer self-efficacy (Celuch et al., 2004; Ong & Lai, 2006; Tung & Chang, 2008). The construct of computer self-efficacy was proposed by Compeau and Higgins (1995). It emerged from the general concept of self-efficacy, which was founded on the social cognitive theory developed by Bandura (1986). Bandura contended that perceived self-efficacy plays an important role in affecting motivation and behaviour. A person may be more likely to undertake behaviours that he or she believes will result in valued outcomes than those perceived as having unfavourable consequences. In the context of using technology, computer self-efficacy represents a person’s perception of his or her ability to use a computer to accomplish a task (Compeau & Higgins, 1995).

In industries outside of health care, the usefulness of TAM in predicting technology acceptance has been rigorously validated by empirical research. However, healthcare researchers are noticeably lagging in that regard (Yarbrough & Smith, 2007). The TAM is a model that has been developed for the general population of technology users. Whether TAM is a fitting theory in the healthcare context is worthy of critical examination (Holden & Karsh, 2010). In addition, in a meta-analysis of TAM as applied in various fields, King and He (2006) explored the moderating effects of type of user and type of use. They found that professionals and general users produce quite different results, and that Internet use is different from job task applications, office applications, and general use. Students, who are often recruited as respondents in TAM studies, are not exactly like professionals or general users. The statistical meta-analysis indicates that both user types and usage types significantly influence technology acceptance.

A number of empirical studies claim to have identified the barriers to the acceptance of technology by healthcare providers (Ash et al., 2003; Austin et al., 2006; Karsh et al., 2006). However, Yarbrough and Smith (2007) have contended that the vast majority of these studies are qualitative and exploratory in nature, and that the degree of acceptance of technology as explained by the determinants cannot be gauged. Additional quantitative research with a large sample size is needed to identify the degree or level of influence that the determinants have on technology acceptance. Furthermore, evaluating TAM using structural equation modelling is

recommended because measurement errors are thereby minimized and construct measurement is more rigorous than regression analysis (Yarbrough & Smith, 2007).

3. Second life

During the past few years, educators from a variety of backgrounds have started using the online 3D world *Second Life (SL)*, created by the US company Linden Lab, to support their teaching and learning activities. Many articles have also been written by these educators on the advantages of using SL to support education (Grassian, Trueman, & Clemson, 2007), convincing ever-increasing numbers of, for example, universities to explore the possibilities of using SL in their teaching and learning activities (Herold, 2009, 2010; Jennings & Collins, 2007). The result has been glowing reports about the future of SL in higher education (Atkinson, 2008).

One of the prominent areas of education in which SL has been used is *medical and health education*. As early as 2007, this use of SL was widespread enough to warrant the publication of general review articles discussing the different projects then underway in the virtual environment (Boulos, Hetherington, & Wheeler, 2007; Skiba, 2007). SL and similar virtual environments have proven especially attractive to educators in medical faculties. This is because their need to provide opportunities for students to *practise* their learned knowledge without endangering other people (e.g., patients, nurses, doctors, etc.) constitutes an important driver in the development of 'safe', virtual environments (Lee & Berge, 2011).

Simulations of healthcare situations in SL, while highly complex and at times difficult to set up, have been used to the great advantage of their students by a growing number of educators (Phillips, Shaw, Sullivan, & Johnson, 2010; Schmidt & Stewart, 2010; Stewart et al., 2010). SL allows educators to design specific problem-based scenarios in which, for example, nursing students can practise their skills in realistic simulations (Rogers, 2009). The flexibility of the virtual world even makes it possible for educators to simulate both the highly computerized and technology-laden environment of a modern hospital (Skiba, 2009; Skiba, Connors, & Jeffries, 2008) and the stress, chaos, and unpredictability of real hospital wards so as to better prepare trainee nurses for their later professional lives (Kilmon, Brown, Ghosh, & Mikitiuk, 2010).

The attempt to use SL in the teaching of rapid sequence intubation (RSI) to nursing students, as discussed in this study, has to be seen in this context. The aim of using SL to teach RSI was to provide students with the possibility of applying what they had learned about the procedure in a realistic setting without endangering the lives of patients. It was thought that a simulated ward, with a simulated doctor and a simulated additional nurse, would give trainee nurses an adequate and safe way of preparing for a potential future need to employ the RSI techniques in a real situation.

4. Simulating rapid sequence intubation in Second Life

Rapid sequence intubation involves the rapid administration of a sedative agent and a neuromuscular blocking agent to induce unconsciousness and motor paralysis for tracheal intubation. This is particularly important, since patients may have a full stomach in emergency situations and are at a much greater risk of vomiting and aspiration (Benger, Nolan & Clancy, 2008). Of course, in the event of a cardiac arrest or unconsciousness, non-RSI endotracheal intubation will be performed on the patient. The objective of RSI is to intubate the conscious

patient safely for emergency airway management, with limited discomfort or pain. A set series of steps form the basis of RSI, known as the seven ‘P’s of RSI: Preparation for intubation, Preoxygenation via bag-valve-mask (BVM) ventilation, Pre-treatment (premedication), Paralysis with induction, Protection and positioning, Placement of the endotracheal tube, and Post-intubation management (Evans & Carroll, 2001).

In this study, we designed and developed a virtual classroom for learning RSI (Fig. 1) and a virtual ward for practising RSI (Fig. 2) on the campus of XXX University in the 3D online world *Second Life*. To practise the skill of RSI, students were required to follow proper procedures before entering the ward or any of the treatment areas. Student avatars entered the ward through a virtual dressing room, in which they first had to change out of their normal clothes into (provided) hospital uniforms, including face masks. On entering a treatment area, and when responding to a simulated respiratory emergency, the avatar had to don additional protective clothing and accessories on top of the hospital uniform before being allowed to continue with the simulation, thus forcing students to practise 'safe' behaviour when in a ward, or when dealing with patients.

[Insert Fig. 1 & 2 here]

The treatment area itself was designed as a standard treatment room with a patient figure lying on a bed, a range of medical equipment ready to be used, as well as a doctor and a nurse already in the room. Both the 'doctor' and the 'nurse' were designed as scriptable 'objects', and the simulation followed a number of possible, but strictly scripted paths based on the actions and responses of the student avatars.

The design of the RSI practice areas in the virtual environment was largely dictated by the possibilities available in the virtual world and by an assessment of the learning requirements of trainee nurses. While SL enables users to create and design almost anything, the motor controls for avatars are insufficient to provide for realistic, controllable movement by student-controlled avatars. Additionally, the graphic system used in SL does not make it possible for avatars to 'insert' anything 'into' another object or avatar, thus the simulation of an actual intubation is not possible. However, this was not a drawback for the training of nurses, as the intubation of patients is the responsibility of doctors, not nurses. For an audience of trainee nurses, it was deemed more important to memorize and practise the necessary steps that nurses are expected to take before, while, and after a doctor is performing an intubation. To achieve this purpose, an 'Assisting RSI' checklist was developed that set out the procedure step by step and included the expected responses from the nurse.

The checklist was used as the basis for developing detailed scripts for the interactions between the student avatars and the treatment room (including the virtual doctor and nurse), and the simulation was designed to 'wait' for the students to figure out the correct responses to each stimulus. Table 1 contains a description of two such steps on the checklist and its corresponding SL scenario descriptions.

[Insert Table 1 here]

If at any stage the student failed to respond for a set amount of time (5 minutes), the simulation paused and offered the student the choice to retry the simulation or to exit. If no reply was received to this prompt after 10 minutes, the simulation reset automatically, and the student avatar was evicted from the hospital ward and returned to the university campus.

Once the student had completed the entire procedure in the virtual ward, the student's performance was saved in a log file. This provided both the student and teaching staff with a record of the student's performance, namely how many of the questions and prompts were repeated, how much time the student took to complete the entire simulation, and so on.

5. Methodology

5.1. Research model and hypotheses

Learning RSI in SL is new to nursing education, and its acceptance by nursing students is of particular interest to this current study. A review of prior studies suggests the theoretical foundations of the hypotheses. The research model examined in this study is based on TAM and augmented by computer self-efficacy (Fig. 3). The component of computer self-efficacy has been incorporated into the TAM model and serves as an extension to TAM for measuring the acceptance of RSI in SL. Numerous empirical studies have also documented the significant influence of behavioural intention on actual system use (Legris et al., 2003; Simon & Paper, 2007). According to Legris et al. (2003), out of 28 TAM-related studies that were reviewed, 17 studies were conducted without measuring actual system use. Owing to the difficulties in interpreting the multidimensional aspects of e-learning use, such as informed versus uninformed and effective versus ineffective use, it has been suggested that the intention to use may be a worthwhile alternative aspect to focus upon (deLone & McLean, 2003; Ong & Lai, 2006). Consistent with such findings and because of the issue of interpretation, the actual use of the RSI in SL was not an aspect of the model that was tested. Figure 4 provides a conceptual map of the research model examined in this study. Five research hypotheses were proposed, based on the TAM relationship:

[Insert Fig. 3 here]

H_1: The computer self-efficacy of nursing students has a positive effect on the perceived usefulness of learning RSI in SL.

H_2: The computer self-efficacy of nursing students has a positive effect on the perceived ease of use of learning RSI in SL.

H_3: Nursing students' perception of its ease of use has a positive effect on the perceived usefulness of learning RSI in SL.

H_4: Nursing students' perception of its usefulness has a positive effect on the behavioural intention to learn RSI in SL.

H_5: Nursing students' perception of its ease of use has a positive effect on the behavioural intention to learn RSI in SL.

5.2. Instrument

The survey instrument measures four constructs of our research model and consists of 13 items (listed in Appendix A). These items were adapted from previously validated instruments and modified to fit the specific technology of the present study. Computer self-efficacy was operationalized using an instrument adapted from Compeau and Higgins (1995). The items used to construct the perceived usefulness and perceived ease of use of TAM were based on the instrument introduced by Venkatesh and Davis (2000). Finally, items for behavioural intention to use were taken from previous applications of TAM (Venkatesh & Davis, 2000; Davis et al.,

1989). All of the items were measured on a seven-point Likert scale ranging from (1) “strongly agree” to (7) “strongly disagree”.

5.3. Sample and data collection

Having obtained ethical approval from the university, undergraduate nursing students in different years of study were approached and invited to participate in workshops on RSI in SL. Since SL was new to the students, an orientation that included how to manipulate their own avatars and interact in the virtual world was also provided in the workshops. At the end of the workshops, feedback was collected from students using the survey instrument. A total of 206 students joined the workshops and returned the instrument. The majority of the respondents were female (73.8%), and all were between 21 and 30 years of age.

6. Results

Table 2 presents the means and standard deviations of both the constructs and the individual item scores. The results of the descriptive statistics indicated that RSI in SL was perceived as useful and that the students felt confident about working with computers and intended to use RSI in SL as often as needed. However, they remained neutral regarding the ease of use of the system. A principal component analysis with a varimax rotation was done to identify the underlying factor structure of the observed variables. The exploratory factor analysis generated four factors with factor loadings ranging from 0.780 to 0.894 (Table 3). All of these loadings were well above the threshold value of 0.4 for retention (Nunnally & Bernstein, 1994). The four factors accounted for 84.97 per cent of the total variance.

[Insert Table 2 & 3 here]

Following the two-step approach of structural equation modelling (SEM) analysis, a confirmatory factor analysis (CFA) was conducted to validate the measurement model before using the structural model to test the hypotheses (Anderson & Gerbing, 1988). The AMOS 17.0 software was used for the SEM analysis in this study.

6.1. Measurement model

The measurement model, which consists of four latent variables, namely computer self-efficacy, perceived usefulness, perceived ease of use, and behavioural intention to use the system, was validated by means of the confirmatory factor analysis. Overall, the measurement model showed a good model-data fit: X^2/df ratio = 1.51; Normed Fit Index (NFI) = 0.96; Non-Normed Fit Index (NNFI) = 0.98; Comparative Fit Index (CFI) = 0.99; and Root Mean Square Error of Approximation (RMSEA) = 0.05. All of the model-fit indices exceeded their respective common acceptance levels suggested by previous research (Gefen et al., 2000; Wu et al., 2008; Tung & Chang, 2008).

The psychometric properties of the measurement model were further examined in terms of reliability, convergent validity, and discriminant validity. The composite reliability (CR) and Cronbach’s alpha of the constructs are given in Table 2. They all exceeded the acceptable criterion of 0.60, meaning that the scales had good reliabilities (Bagozzi & Yi, 1988; Fornell & Larcker, 1981). The interpretation of CR is similar to that of Cronbach’s alpha. However, instead of assuming each item to be equally weighted in the composite determination, CR also takes into account the actual factor loadings. In this study, unidimensionality and average variance

extracted (AVE) were used as indicators of convergent validity (Bagozzi & Yi, 1988). To assess unidimensionality, both the factor loading (> 0.5) and t-value (> 1.96) of items are required. As shown in Table 2, the factor loadings of the items in the research model ranged from 0.69 to 0.93 and were significant at the level of $p < .001$. All were greater than the recommended benchmark of 0.50 (Hair et al., 1992). In addition, the AVEs were all above the threshold value of 0.50 (Hair et al., 1992), indicating that the hypothesized factors accounted for more than one half of the variances observed in their measurement items. To test the discriminant validity, the square root of the AVE of each construct and its correlation coefficients with other constructs were compared. Table 4 presents the results for comparison. For all the constructs, the square roots of the AVEs were larger than the correlation coefficients with other constructs, thus showing good discriminant validity (Kerlinger & Lee, 2000; Fornell & Larcker, 1981). In summary, all constructs in the measurement model had adequate reliability, convergent validity, and discriminant validity.

[Insert Table 4 here]

6.2. Structural model

Testing of hypotheses was conducted within the context of the structural model. The structural model consisted of one exogenous variable (i.e., computer self-efficacy) and three endogenous variables (i.e., perceived usefulness, perceived ease of use, and behavioural intention to use). Similar to the measurement model, the comparison of fit indices with their corresponding recommended values demonstrated evidence of a good model fit (X^2/df ratio = 1.63; NFI = 0.96; NNFI = 0.98; CFI = 0.98; RMSEA = 0.06).

Figure 4 presents the properties of the causal paths, including standardized path coefficients, p-values, and variance explained for each equation in the hypothesized model. All of the hypotheses were supported because their respective path coefficients were significant at the level of $p < 0.001$. However, computer self-efficacy only explained 7 per cent of the variance in perceived ease of use. Both computer self-efficacy and perceived ease of use had a significant positive effect on perceived usefulness, altogether accounting for 47 per cent of the variance in perceived usefulness. The research model accounted for 54 per cent of the variance in the behavioural intention to use RSI in SL.

[Insert Fig. 4 here]

The direct, indirect, and total effects of computer self-efficacy, perceived usefulness, and perceived ease of use on behavioural intention to use are summarized in Table 5. Among all the predictor variables, perceived ease of use exhibited the strongest total effect on behavioural intention to use (0.63), followed by perceived usefulness (0.38) and computer self-efficacy (0.31). It is worth noting that perceived ease of use exhibited a strong direct effect on both perceived usefulness (0.47) and behavioural intention to use (0.45).

[Insert Table 5 here]

7. Discussion

In this study, we explored factors affecting the intention of nursing students to use a virtual environment for learning RSI based on TAM. Overall use of the TAM in this context was successful, indicating the robustness of the model. The findings suggested that the system was

perceived to be useful and that students in general were confident about their computer skills and intended to use the system in the future. We also examined and validated the extended TAM in the context of learning RSI in SL. The measurement model was confirmed with adequate reliability, convergent validity, and discriminant validity. In the structural model, all path coefficients were found to be statistically significant.

The strengths of this study include a large sample size, using well-validated questionnaire items from previous studies, and employing SEM in model testing to ensure methodological rigour. Given these preconditions, the extended TAM with computer self-efficacy explained 54% of the variance in behavioural intention. This is a reasonably high value, and it provides evidence that TAM may capture some of the unique contextual features of e-learning in healthcare education. To further increase the amount of explained variance and the model's accuracy, Holden and Karsh (2010) proposed a specific process, which they called *beliefs elicitation*, for contextualizing TAM. Based on responses to open-ended questions in an elicitation study, researchers identify salient beliefs that participants have about a certain kind of behaviour. The solicited beliefs become the basis for a subsequent theory. They believe that conducting elicitation studies with healthcare providers, focusing on the salient aspects of their health IT use in the healthcare context, will allow researchers to probe the participants about a wide range of theoretically interesting beliefs. This may lead to more refined, more robust, and contextualized theories of health IT use and acceptance. An important future direction for TAM may be to adapt the model specifically to the healthcare context, and evolve a theory of health IT, using beliefs elicitation methods.

The tradition of adding variables is common in research on TAM, and it appears to be the approach advocated by some researchers to further the use of TAM in health care (Wu et al., 2008; Yarbrough & Smith, 2007; Yi et al., 2006). In this study, computer self-efficacy as an added variable appeared to be a significant determinant of perceived usefulness and perceived ease of use. Similar findings were reported in studies conducted by Ong, Lai, and Wang (2004), and Park (2009) that also explored the importance of computer self-efficacy in the adoption of e-learning. Students with higher computer self-efficacy are likely to have more positive beliefs about the usefulness and ease of use of an e-learning system. Computer self-efficacy was also found to have an indirect effect on the behavioural intention to use the system. However, it was found that computer self-efficacy only explained 7 per cent of the variance in perceived ease of use. Even though students in general were confident about their computer skills, the findings revealed that they did not find the virtual ward easy to use, as the perceived ease of use construct received only an average score of 4 out of a range of 1 (strongly agree) to 7 (strongly disagree). This might help to explain the relatively small effect that computer self-efficacy had on perceived ease of use. Second Life, being a different type of technology than those analyzed in previous studies on TAM, could explain in part the differences encountered in this study.

Across the many empirical tests of TAM, perceived ease of use exhibited a less consistent effect on intention (Venkatesh & Davis, 2000). The results of this study strongly support perceived ease of use as the most influential construct to directly affect perceived usefulness and behavioural intention. This suggests that when introducing the RSI in SL, strategies should be employed to boost the self-confidence of students in using the system, such as simplifying students' access to the virtual ward and the performance of their duties through changes in the design of the virtual environment, providing longer introductory sessions before attempting the simulation to familiarize them with the virtual environment in general, and enhancing both on-

and off-line support services. If students are struggling, they may actually believe that the system is too difficult to use and that the benefits of using RSI in SL are outweighed by the effort required to use it. Eventually, they may become reluctant to use the system, thus defeating the purpose of introducing it.

Perceived usefulness has consistently been a strong determinant of usage intention (Venkatesh & Davis, 2000), and similar results were found in this study. Students in general found RSI in SL to be useful, despite the fact that their use of the system was voluntary and the subject matter was not yet part of the formal undergraduate nursing curriculum. Currently, establishing a patent airway by non-RSI endotracheal intubation is a core topic in basic nursing education. Since RSI requires a high level of knowledge and understanding of various clinical conditions, training in this complex technical skill is only offered to registered nurses or critical care nurses. Hence, most new graduates are inadequately prepared in this area even though RSI is an increasingly frequent method of acute airway management (Crown & Singh, 2004). Learning RSI in SL, on a voluntary basis, was useful in reducing the students' unmet learning needs. This might have enhanced their perception of the usefulness of learning RSI in SL.

Second Life is showing potential as an effective platform for healthcare education (Skiba, 2009). In this study, RSI in SL replicates real-world learning experiences previously available only through face-to-face encounters. It also helps learners to bridge the gap between knowledge and application by providing an opportunity to use a simulation in a safe environment, and allowing them to practise the skill and learn from their mistakes without disadvantage. The simulation activities can also enhance critical-thinking skills and allow learners to take risks and make decisions independently. Learners are able to access and repeat practices in SL as many times as they desire, enabling them to self-direct their learning until such a time as they feel comfortable with the procedure and can practise without harm to patients (Schmidt & Stewart, 2010).

The findings of this research should be considered in light of its limitations. First, this study was conducted in a single university, which raises the problem of generalization. Second, participation in this study was voluntary and therefore inevitably subject to the self-selection biases of the participants. Students who were inclined to e-learning might have been more likely to respond to the survey. For various reasons, it is important to understand healthcare providers' acceptance of technology. Future research may include other external constructs such as concentration (Liu, Liao & Pratt, 2009) and hedonic consumption (Holsapple & Wu, 2007) to further extend the TAM. In addition, students' perceptions can change over time. For example, perceived ease of use may be pivotal at first and less important as time goes by (Venkatesh et al., 2003). Future work should measure the variables at several points in time, and the findings may enhance our understanding of the causality and interrelationships between the variables. In this study, we explored the intention of nursing students to use SL for e-learning. Types of healthcare providers, such as physicians and pharmacists, are another moderator deserving of further inquiry.

8. Conclusion

The gap between the design and implementation of e-learning, and actual usage could be bridged by focusing upon the identified determinants of TAM. The use of virtual worlds in healthcare education is to be supported, but such a use should be well embedded into existing

educational processes, and the usefulness of SL within the e-learning environment should be emphasized. The presence of technology-specific training and support, and the infrastructure needed to properly implement an e-learning system is critical to the successful introduction of virtual worlds in healthcare education. By incorporating additional factors into the model, such as computer self-efficacy to determine acceptance of e-learning, a better understanding of the TAM in healthcare education can be obtained.

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Highlights

- Findings suggested that the system was perceived as useful.
- Students intended to review rapid sequence intubation in Second Life as often as needed.
- Perceived ease of use was the most influential construct to affect behavioural intention directly.
- The research model accounted for 54 percent of the variance in behavioral intention.
- Overall use of the technology acceptance model in this context was successful.

Appendix A
Survey items

Computer self-efficacy
CSE1 I am comfortable working with computers.
CSE2 If I am given some training, I can learn to use most computer programs.
CSE3 I can learn to use most computer programs just by reading the manuals and help.

Perceived usefulness
PU1 RSI in Second Life can improve my learning efficiency.
PU2 RSI in Second Life can enhance my learning performance.
PU3 RSI in Second Life increases my learning output.
PU4 I find RSI in Second Life is useful for my learning.

Perceived ease of use
PEOU1 It is easy to operate RSI in Second Life and get it to do what I want it to do.
PEOU2 I find that RSI in Second Life is very easy to use.
PEOU3 I find that the human interface of RSI in Second Life is clear and easy to understand.
PEOU4 I find that interacting with RSI in Second Life doesn't demand much care or attention.

Behavioral intention to use
BI1 Given that I had access to RSI in Second Life, I predict that I would use it.
BI2 I intend to use RSI in Second Life as often as needed.

RSI, Rapid Sequence Intubation

Table 1
Checklist and its corresponding Second Life scenario descriptions

<table>
<tr><th colspan="3">Protection and positioning II – Step 18 (out of 40)</th></tr>
<tr><th>Assisting RSI checklist</th><th colspan="2">Second Life scenario description</th></tr>
<tr><td rowspan="2">Observe for
a. apnea,
b. jaw relaxation,
c. decreased resistance to bag-mask ventilations
(patient sufficiently relaxed to proceed with intubation)</td><td>Virtual Doctor</td><td>Student Avatar</td></tr>
<tr><td>Pop up 1:
"What should you observe after the paralyzing agent is given?"

Next student avatar options popup

Pop up 2:
"Yes, all have to be observed."

Next proceed with simulation</td><td>Options popup
1. apnea,
2. jaw relaxation
3. decreased resistance to bag-mask ventilations

Repeat until all are chosen
then Virtual Doctor Pop up 2</td></tr>
<tr><td colspan="3"></td></tr>
<tr><th colspan="3">Post Intubation management I – Step 25 (out of 40)</th></tr>
<tr><th>Assisting RSI checklist</th><th colspan="2">Second Life scenario description</th></tr>
<tr><td rowspan="2">Inflate cuff on ETT with
5 cc to 10 cc of air</td><td>Virtual Doctor</td><td>Student Avatar</td></tr>
<tr><td>Pop up 1:
"Inflate the cuff now!"

Next student avatar question
- - - - - - - - - -
Pop up 2:
"20-30 cc? Too much air!"

Next student avatar question
- - - - - - - - - -
Pop up 3:
"Now the cuff is inflated!"

Next proceed with simulation</td><td>Question:
How much air should you inject?

Options popup
a. 5 cc – 10 cc of air
b. 20-30 cc of air

If a
then Virtual Doctor Pop up 2

If b
then Virtual Doctor Pop up 3</td></tr>
</table>

RSI, Rapid Sequence Intubation; ETT, endotracheal tube

Table 2
Descriptive statistics, average variance extracted (AVE), composite reliability (CR) and factor loading of construct measurement

Variables	Mean[a]	Std Dev	Factor loading	t-value	AVE	CR	Alpha
Computer self-efficacy	3.09	1.21			0.74	0.77	0.90
CSE1	3.12	1.40	0.87	30.13			
CSE2	2.97	1.21	0.85	32.61			
CSE3	3.19	1.36	0.85	32.92			
Perceived usefulness	2.92	0.95			0.80	0.82	0.95
PU1	2.86	1.03	0.89	41.16			
PU2	2.92	1.02	0.89	42.40			
PU3	2.93	1.01	0.91	43.01			
PU4	2.99	1.03	0.89	42.31			
Perceived ease of use	4.00	1.21			0.72	0.75	0.91
PEOU1	4.05	1.41	0.91	50.10			
PEOU2	4.25	1.45	0.93	52.31			
PEOU3	3.83	1.29	0.85	52.12			
PEOU4	3.87	1.30	0.69	51.82			
Behavioral intention to use	3.61	1.31			0.84	0.85	0.93
BI1	3.48	1.36	0.93	41.44			
BI2	3.75	1.35	0.90	47.18			

[a] 1 – strongly agree and 7 – strongly disagree

Table 3
Results of exploratory factor analysis

	Factor			
	1	**2**	**3**	**4**
Computer self-efficacy				
CSE1	0.235	0.065	**0.872**	0.136
CSE2	0.196	0.039	**0.874**	0.096
CSE3	0.166	0.129	**0.894**	0.070
Perceived usefulness				
PU1	**0.862**	0.220	0.188	0.185
PU2	**0.890**	0.166	0.198	0.180
PU3	**0.853**	0.275	0.243	0.161
PU4	**0.836**	0.285	0.202	0.174
Perceived ease of use				
PEOU1	0.237	**0.870**	0.066	0.164
PEOU2	0.223	**0.878**	0.032	0.207
PEOU3	0.236	**0.822**	0.145	0.250
PEOU4	0.155	**0.780**	0.067	0.152
Behavioral intention to use				
BI1	0.319	0.345	0.201	**0.821**
BI2	0.265	0.412	0.138	**0.821**

Table 4
Square root of average variance extracted (AVE) and correlations of all constructs

		1	2	3	4
1	Computer self efficacy	**0.86**			
2	Perceived usefulness	0.51	**0.89**		
3	Perceived ease of use	0.25	0.57	**0.85**	
4	Behavioral intention	0.45	0.63	0.66	**0.92**

Square roots of AVEs are shown as diagonal elements in bold type. The diagonal elements were greater than the corresponding off-diagonal elements in the same row and column, indicating the discriminant validity.

Table 5
The direct, indirect, and total effects of variables on behavioral intention to use

	Direct effect			**Indirect effect**			**Total effect**		
	PU	PEOU	BI	PU	PEOU	BI	PU	PEOU	BI
CSE	0.39	0.26		0.12		0.31	0.51	0.26	0.31
PU			0.38						0.38
PEOU	0.47		0.45			0.18	0.47		0.63

CSE, computer self efficacy; PU, perceived usefulness; PEOU, perceived ease of use; BI, behavioral intention to use.

Fig. 1. A virtual classroom for learning rapid sequence intubation.

Fig. 2. A virtual ward for practicing rapid sequence intubation.

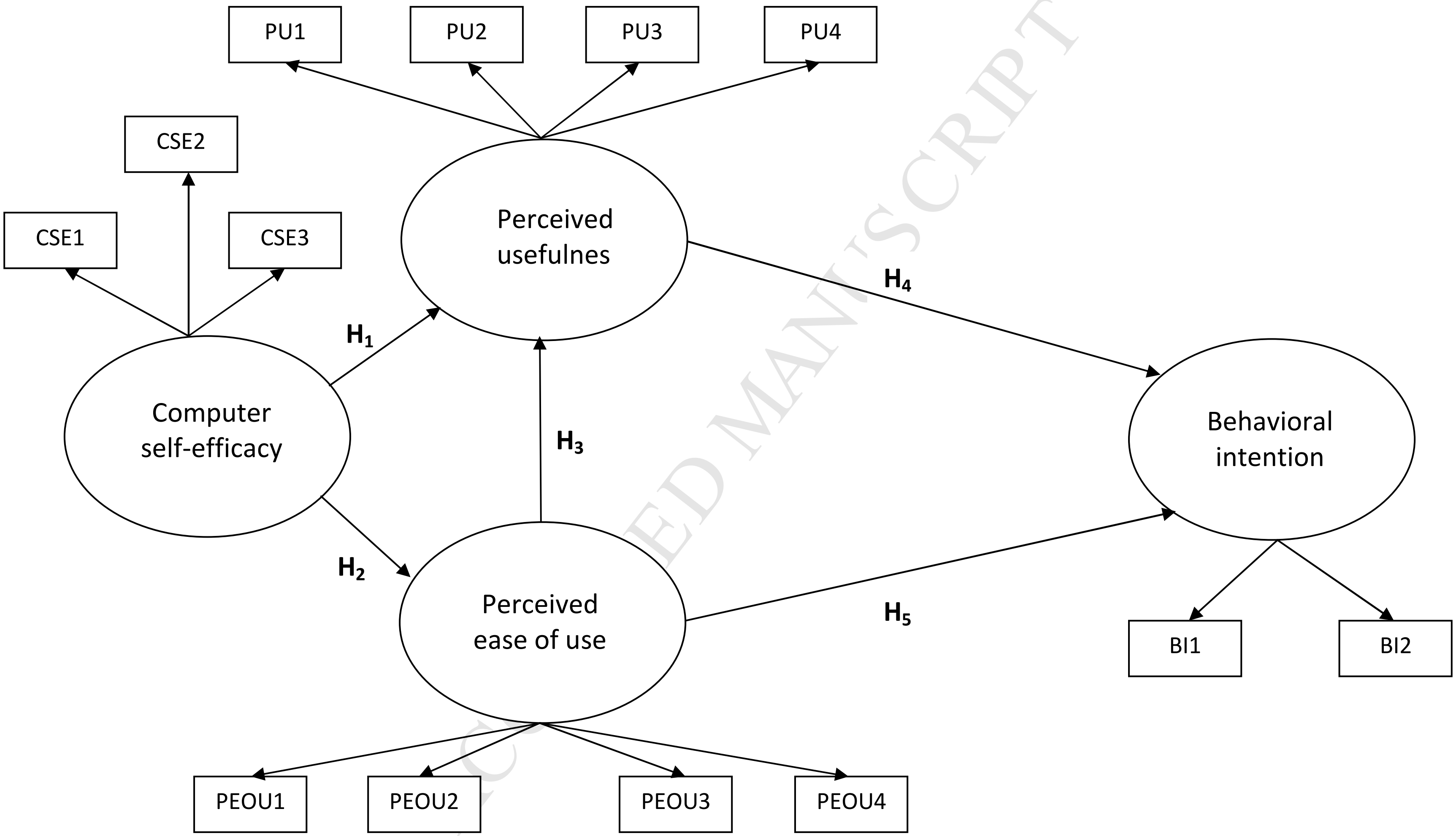

Fig. 3. Research model and hypotheses.

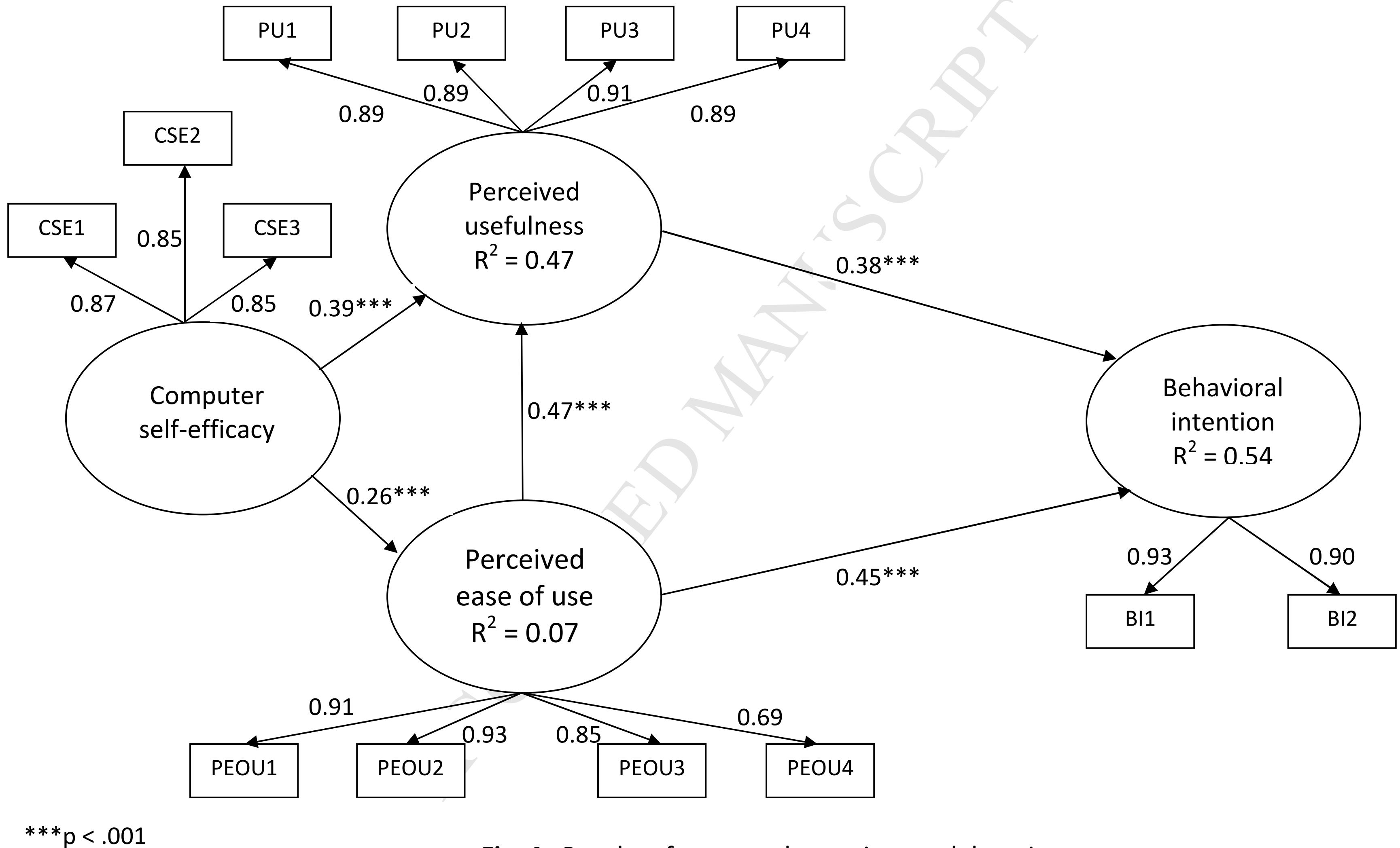

Fig. 4. Results of structural equation model testing.